Anakie Solar Farm

Glint and Glare Assessment

Prepared for: **NGH Consulting**

Project No: **2152** Issue: **Rev C** Date: **02.08.2022**

ADVERTISED PLAN

DOCUMENT HISTORY AND STATUS

Project No: **2152**

Project Name: **Anakie Solar Farm**

Issue	Status	Date of Issue	Author	Approved by
A	Draft issued for review	02.05.2022	SW	AR
B	Final Issue for Submission	01.08.2022	SW	AR
C	Final Issue for Submission	02.08.2022	SW	AR

1.0 Introduction

Moir Landscape Architects has been engaged by NGH Consulting to assess the potential glint and glare impacts of the proposed Anakie Solar Farm (the Project) in Anakie, south western Victoria. The Project will include construction, operation and maintenance of a Photovoltaic (PV) system with a capacity of less than 5 Megawatts (MW) and other associated ancillary infrastructure.

The Project is located Approximately 6 km to the south of Anakie town centre and about 18 km to the north west of Geelong. The development boundary forms part of a larger Site (Refer Figure 1). The PV system will be orientated north-south, mounted on a single axis horizontal tracking system. The overall height will be a maximum of 5.10 metres.

The facility will have a dedicated power station within the development boundary which will be connected to the existing overhead transmission line running along Geelong - Ballan Road.

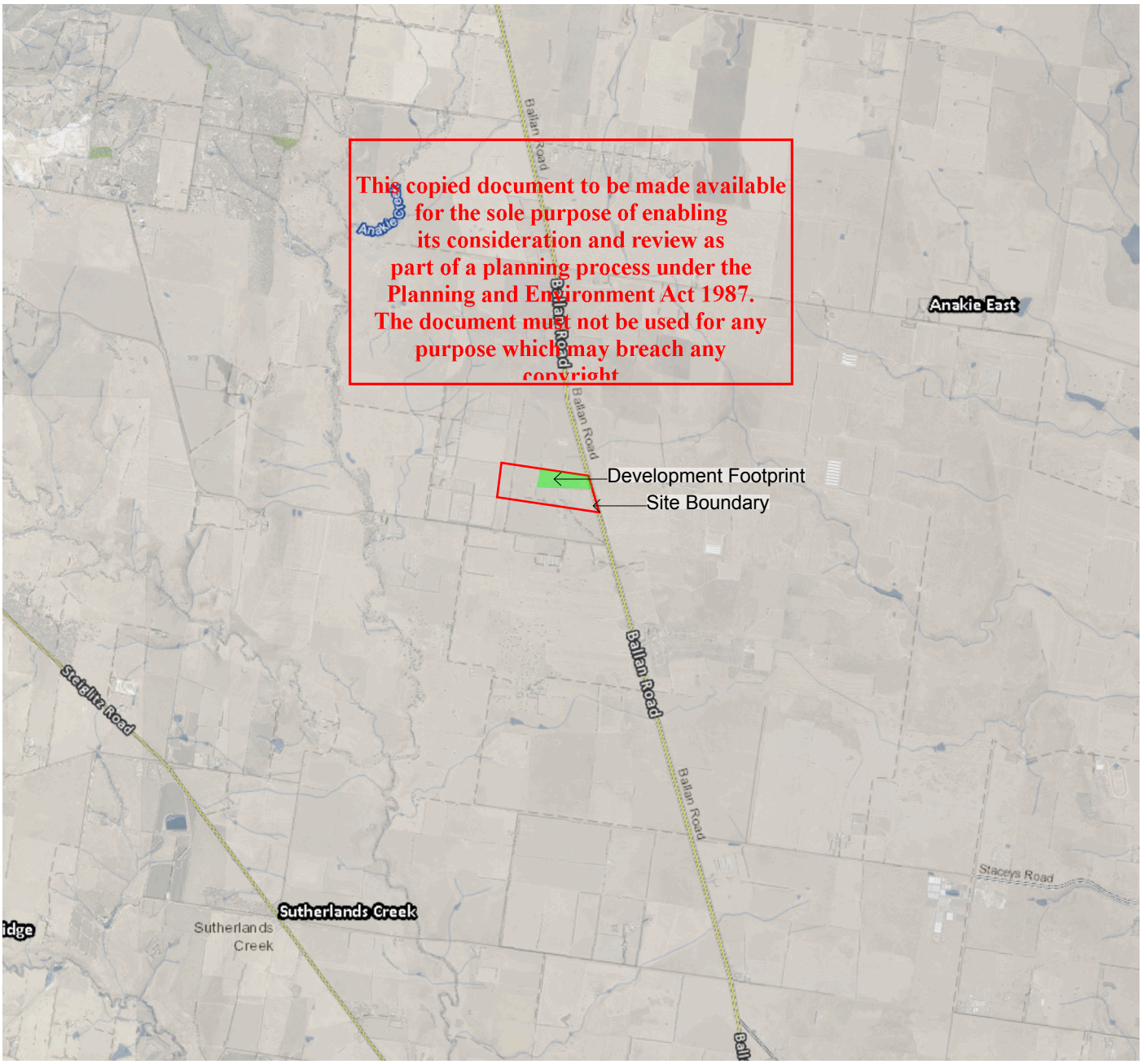


Figure 1: Project Location *(Source: Vicplan)*

2.0 Study Method

2.1 Overview of Glint and Glare

Glint is generally defined as a momentary flash of bright light while Glare can be defined as continuous source of excessive brightness proportionate to ambient lighting (FAA 2018) . The Glare analysis tool used to assess the glint and glare hazard was run at a simulation interval of one minute, based on the reflectivity of solar rays off PV modules which typically lasts for at least one minute.

Although Solar photovoltaic (PV) modules are designed to absorb as much light as possible, the glass modules and supporting frames have a tendency to generate glare. Assessment needs to be undertaken to ensure that sensitive visual receptors such as road users, surrounding rail network, nearby buildings, air traffic controllers and pilots are not impacted by the proposed development. (ForgeSolar, 2022)

2.2 Study Method

The Solar Glare Hazard Analysis Tool (SGHAT) developed by Sandia National Laboratories is used to evaluate glare resulting from solar farms at different receptors, based on proximity, orientation and specifications of the PV modules. This tool is recognised by the Australian Government Civil Aviation Safety Authority (CASA).

SGHAT is used to indicate the nature of glare that can be expected at each potential receptor. Glare can be broadly classified into three categories: low potential for after image, potential for after image, and potential for permanent eye damage. This is indicated by three colours:

- **Green Glare**: Low potential for temporary after-image
- **Yellow Glare**: Potential for temporary after-image
- **Red Glare**: Retinal burn, not expected for PV.

2.3 Glare Assessment Parameters

Glint and Glare assessment modelling for the solar farms in the SGHAT tool is based on the following factors:

- Position of the sun over time with respect to the location of the proposed solar farm.
- Tracking axis tilt, tracking axis orientation and properties of the PV modules.
- Location of sensitive receptors (receivers) from the Project including residential dwellings, Road and Rail receptors and Flight path receptors.
- Potential to screen the impact by surrounding topography.

2.4 Assumptions

The glare and glint impact is calculated utilising the geographic location, elevation, position of the sun and other vector calculations including module orientation, reflective environment and visual factors. Sun position is determined at every one (1) minute interval through out the year. Although the SGHAT is an extensive tool to understand the impacts of potential glare, it does not consider backtracking procedures in relation to the PV array tracking system, weather conditions, separation between PV modules and existing surrounding vegetation (if present) between the Project and a sensitive receiver.

Single axis tracking PV panels capable of rotating to a maximum of 60° have been considered for this analysis. The trackers are oriented north south with a maximum pitch distance of 6.5 metres. Due to the scope of the Project, potential visual receptors within 2000 metres of the site were considered which include nearby dwellings, sheds or outhouse buildings, rail network and road route users,

The visual impact of solar farm development depends on the scale and type of infrastructure, the prominence and topography of the site relative to the surrounding environment, and any proposed screening measures to reduce visibility of the site.

2.5 Backtracking Operations

A single axis horizontal tracking system can be configured to do a 'backtracking' technique, which implies that when the sun is low in the sky in the morning or evening, the tracking system can adjust the panels to maximise solar capture while minimising overshadowing.

ForgeSolar uses a simplified model of backtracking. Single-axis trackers follow the movement of the sun as it moves east to west throughout the day. Yields are maximized, and light reflection is minimised when panels are directly facing the sun. In times when the sun is not in the tracking range, we assume that the panels instantaneously revert to their resting angle of 0° (flat). Due to this, glare from the backtracking mechanism will be more conservatively simulated and at times of sunset and sunrise, when the sun is at a lower angle relative to the array, glare impacts will be more noticeable.

Variable angles of incidence of the sun relative to the panels may occur when the tracking system is performing a backtracking operation, and this variation is not yet represented by SGHAT software. However, SGHAT has a 'resting angle' option that simulates the impression of the panels returning to a predefined angle after the maximum tilt angle has been attained. It is important to note that 'resting angle modelling' is not a realistic representation of how a backtracking technique would work in actuality but on the other hand, gives some idea of the potential glare consequences of shifting the PV panels away from the sun after the maximum tilt is reached.

The following parameters have been considered to simulate a typical backtracking process for the proposed development:

- A maximum tracking angle of 60° is considered to indicate a full rotational range of 120°.
- To simulate 'backtracking', 'resting angle' determined as 45°, assuming the PV modules move directly to 45° once

maximum tilt of 60° is reached and represents a worst case scenario.

- To simulate glare experienced mid tracking, an angle of 22° is considered assuming the PV modules move from the resting angle prior to arriving at the stowing angle.
- Night time angle (stowing angle after dark) of 5° is considered assuming the PV modules move directly to 5° once maximum tilt of 60° is reached and represents a worst case scenario.

3.0 Project Overview

3.1 Study Area

Surrounding landscape within the vicinity of the project can be characterised as a rural landscape naturally cleared to support agricultural activities. The topography has slight undulations with an average slope of 1.3% across the Project. Anakie Creek Channel runs along the eastern edge of the Project and is located approximately 2.32 km from the Project. The Site and the surrounding land has been zoned as Farming Zone (FZ). Assessment of the aerial imagery indicates a dense boundary vegetation along the southern Project boundary. Eastern and northern edges of the Project appear to have scattered rows of vegetation. The western edge borders the Geelong - Ballan Road which will serve as an access to the Project. There is also an existing overhead transmission line running along Ballan Road. The proposed development will use the existing transmission line to transfer the energy produced through a point of insertion. For the purposes of this assessment sensitive receptors within the 2.0 kilometre ('Study Area') have been identified. 23 receptors have been identified within the Study Area of the Project. Few dispersed dwellings outside the 2.0 km radius do not form part of this assessment.

No other significant features were identified within the landscape that would contribute to the potential glare.

3.2 Modules and Array Layout

Each module consists of P type Mono-crystalline cell type with a 2.0 mm, anti-reflection coated semi-tempered glass set in an anodised aluminium alloy frame (Suzhou Talesun Solar Technologies Co., Ltd. 2021). There will be an estimated 10625 modules mounted on a north/south axis to slowly track movement of the sun. Refer **Figure 2** for PV array stages.

A single axis tracking system follows the sun's trajectory and rotates the panels across east to west. To attain optimum solar energy collection, the project modelling has utilised a maximum rotational range of 120°. The tracking tilt angle upon which the panels rotate is considered as 0.74 degrees to match the average ground slope of the Site. The panels are fixed on a tubular frame with a single axis tracking procedure. The panels will have a maximum height not exceeding 5.10 m when facing at the highest angle and a maximum of 4.99 meters when horizontal. The rows of modules will be spaced approximately 6.5 m apart to ensure no shading occurs and allows for ease of access for maintenance purposes.

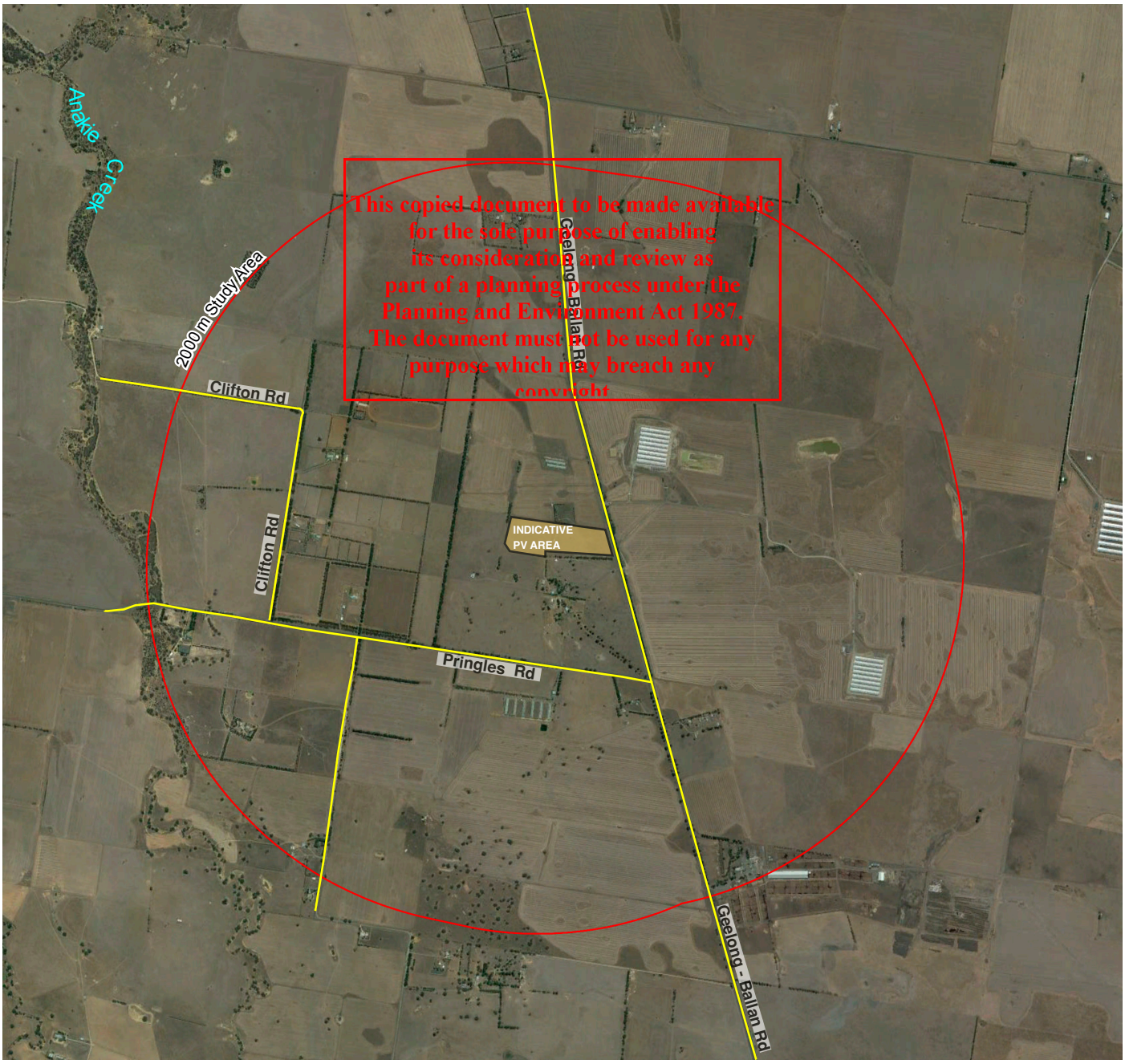


Figure 2: PV Array Stages *(Source: Google Earth)*

4.0 Modelling parameters

4.1 Panel Specifications

The Solar Panels have been assessed based on a maximum height of 5.10 metres above ground level.

General Solar PV system inputs:			
Input Data	**Units**	**Value**	**Comments**
Time Zone	UTC	+11	VIC time Zone
Orientation of Array	Degrees	0	Rows aligned in north-south directions
PV Surface materials	-	Smooth Glass with Anti-reflective Coating	Provided by the Client
Mounting Type	-	Single Axis Tracking	As per tracker data sheet
Single Axis Tracking Parameters			
Axis Orientation	Degrees	0	Panels orientated north south
Axis Tilt	Degrees	0.74	Elevation of tracking axis. Average ground slope is approximately 0.74 degrees (Google Earth)
Module Offset angle	Degrees	0	Facing upwards Panels rotate during operation
Max tracking angle	Degrees	±60° (Range of 120°)	Panels following the Sun
Resting angle	Degrees	0°, 22°, 45°, 5°	Panels following the Sun, to represent backtracking and after dark stowing angles
Height	Metres	5.10	

Table 1. Summary of modelling parameters

4.2 Eye Height

The following assumptions have been applied to assess receptors:

An average eye height of 2.4 metres has been considered to represent a truck driver's eye height (worst case scenario) (Austroads Ltd. 2021). For all dwelling receptors, an average eye height of 1.5 metres has been considered for the purposes of this assessment. Moir LA have assessed the routes with the above mentioned parameters to ensure a worst case scenario:

Eye Height for Receptors:	
- Road Receptors (Min): *Representative of eye level for commercial vehicle*	**1.8 m Above Ground Level**
- Road Receptors Max: *Representative of eye level for truck drivers*	**2.4 m Above Ground Level**
Dwelling Receptors	**1.5 m Above Ground Level**

Table 2. Parameters for receptors

5.1 Potential Receptors

Four (4) route receptors, and 23 dwelling/sheds receptors (OP1 - OP23) have been identified within 2000 metres of the Project. The four receptor routes include Geelong - Ballan Road fronting the Project, Clifton Road to the west, Pringles Road and Southerlands Creek Road to the south. Refer to **Figure 3.**

No airstrips or flight paths were identified within 2000 metres of the Project. Lethbridge Aerodrome is located approximately 15 km north east of the Project. Avalon International Airport is also located in approximately 19 km southeast of the Project. Upon further investigation through a desktop review, there appear to be two private airstrips - Lovely Banks Airstrip and Wooloomanata Airstrip located approximately 10 km from the Site to the east and the southeast. These flight receptors are too far to assess potential glare of the Project and therefore do not form part of this assessment.

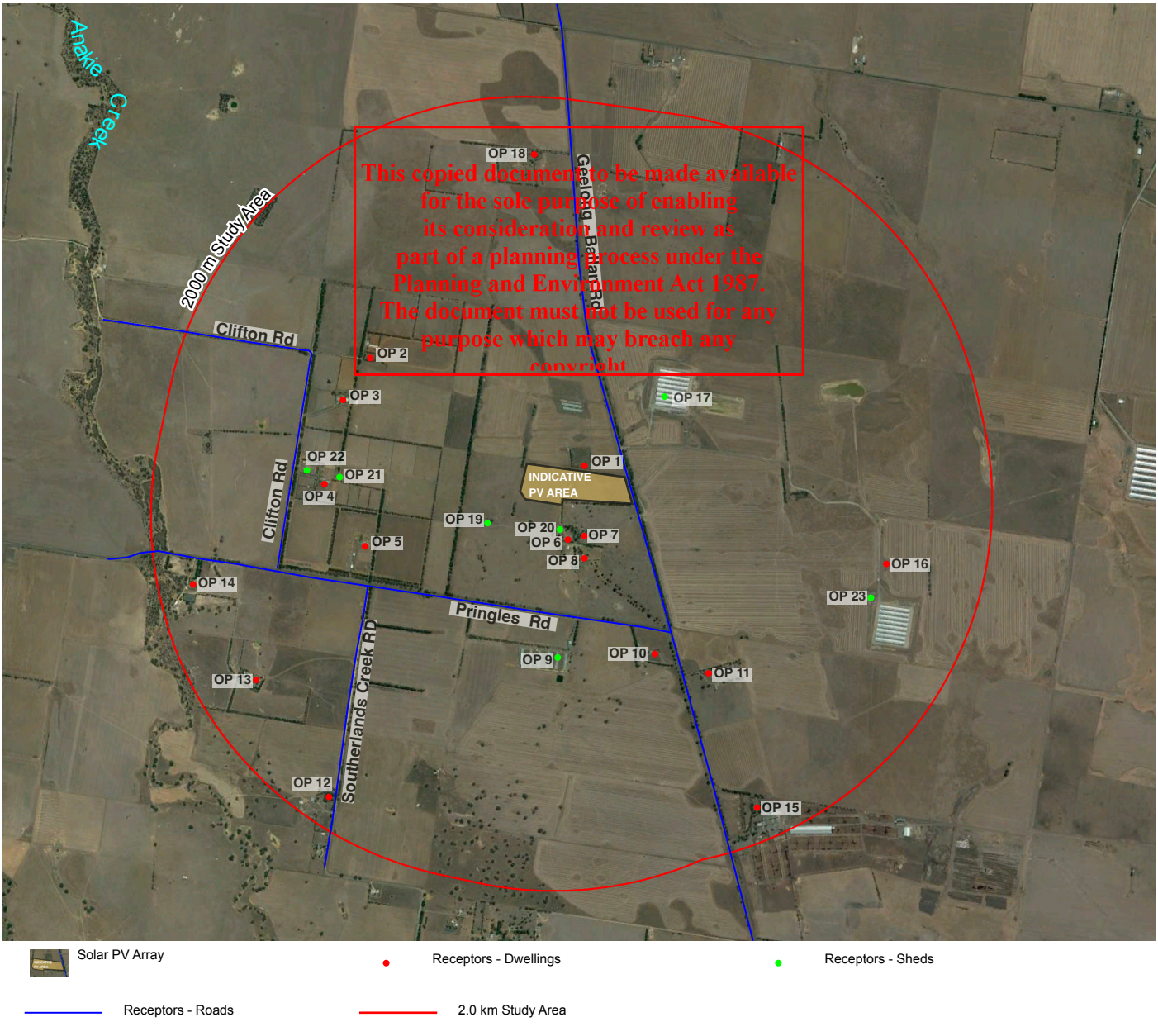


Figure 3: Locations of Receptors *(Source: Google Earth)*

6.0 Glint and Glare Assessment

6.1 Overview of Dwelling Receptors

Based on the desktop assessment no receptors (OP1 - OP23) have been identified to experience glare from the Project. Mitigation measures in the form of proposed and existing vegetation will further help in reducing potential to views of the Project at these locations. The time of day glare likely to be experienced is provided for each receptor in **Appendix A**.

6.2 Overview of Route Receptors

Four (4) route receptors were identified within the Study Area and formed part of this assessment. These include Geelong-Ballan Road, Clifton Road, Sutherlands Creek Road and Pringles Road. Based on desktop assessment one (1) route receptor has been identified to experience minimal 'Green' glare from the Project. Clifton Road will experience a total of 8 minutes annual Green Glare from the Projects limited to late January and early to mid November between 05:00 am to 06:00 am. Glare impacts outputs for each route receptor is provided in **Appendix A**.

Table 3: Glare mins / year for dwelling receptors

7.0 Summary and Recommendations

7.1 Summary of Results

No potential 'Yellow' glare will be experienced at dwellings neighbouring the Project Most of the locations have either existing vegetation surrounding the receptors or are at some distance from the receptors. Glare Impact studies also indicates one (1) route receptors - Clifton Road will experience potential glare from the Project. .

Various resting angles have been tested for backtracking and the resting angle does not change the outcomes of this assessment.

8.0 Mitigation Measures

Desktop assessment indicates only low potential for an after image predicted along Clifton Road. Intervening vegetation associated with roadside vegetation and surrounding residential properties will reduce the potential to experience glare impacts along Clifton Road. An overview of potential glare experienced by dwellings and other receptors including receptor routes, public viewing locations and sheds within the 2 kilometre 'Study Area' have been discussed in **Section 6** of this report.

9.0 Conclusion

The purpose of this report was to identify potential glint and glare impacts from the proposed Anakie Solar Farm on the surrounding dwellings and receptors routes within 2000 metres of the Project. Modelling was conducted along receptor routes and nearby dwellings receptors including out buildings or sheds identified within the Study Area. A desktop review indicated no flight paths or airstrips present within 2000 metres of the Project. Based on the assumptions and aforementioned parameters in this report a low potential for an after image was detected only along Clifton Road. Potential glare along Clifton Road has been indicated to occur between 05:00 am to 6:00 am from late January and mid to late November for 8 minutes annually.

No potential glint or glare was identified at a resting angle of 5°, 22° and 45° to simulate backtracking operations when the PV modules reverted to a night time stowing angle after dark.

REFERENCES

Austroads Ltd. 2021, Guide to Road Design Part 3: Geometric Design, AGRD03-16, Austroads Ltd., Sydney, NSW.

Australian Rail Track Corporation Limited 2010, Signal Sighting and Position, ESC-04-01, Australian Rail Track Corporation Limited, Sydney.

Transport Asset Standards Authority 2020, Minimum Operating Standards for Rolling Stock – General Interface Requirements, T HR RS 00100 ST, Transport NSW, Sydney.

ForgeSolar n.d., www.forgesolar.com, viewed 27 April 2022, <https://www.forgesolar.com/help/#glare>.

Map of airports in Victoria, Australia @ OurAirports n.d., ourairports.com, viewed 29 April 2022, <https://ourairports.com/countries/AU/VIC/>.

Suzhou Talesun Solar Technologies Co., Ltd. 2021, Bipro TD7G78M 156 half-cell 570-590W Bifacial Dual Glass 10BB half-cut Mono Perc, TD7G78M, Suzhou Talesun Solar Technologies Co., Ltd.

Vicplan 2019, Geocortex Viewer for HTML5, Vic.gov.au.

ADVERTISED PLAN

APPENDIX A: ForgeSolar SGHAT Outputs

Updated: 01st August 2022

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM 20220801**
Analysis conducted by David Moir (itsupport@moirla.com.au) at 23:47 on 31 Jul, 2022.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 73363.11981
Methodology: V2

PV Array(s)

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.248739	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Route Receptor(s)

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238435	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Array Area 01	SA tracking	SA tracking	8	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	8	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Results for: PV Array Area 01

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	8	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

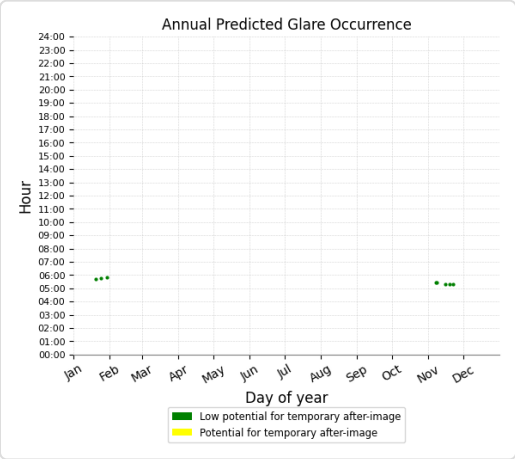
Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Route: Clifton Road

0 minutes of yellow glare

8 minutes of green glare



Route: Geelong-Ballan Road

0 minutes of yellow glare

0 minutes of green glare

Route: Pringles Road

0 minutes of yellow glare

0 minutes of green glare

Route: Southerlands Creek Road

0 minutes of yellow glare

0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM 20220801**

Client: NGH

Created 31 Jul, 2022
Updated 31 Jul, 2022
Time-step 1 minute
Timezone offset UTC10
Site ID 73363.11981
Category 1 MW to 5 MW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	8	0.1	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	8	0.1	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 0.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Route Receptors

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238436	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.249730	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Glare Analysis Results

Summary of Results

Glare with low potential for temporary after-image predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	8	0.1	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	8	0.1	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV: PV Array Area 01 low potential for temporary after-image

Receptor results ordered by category of glare

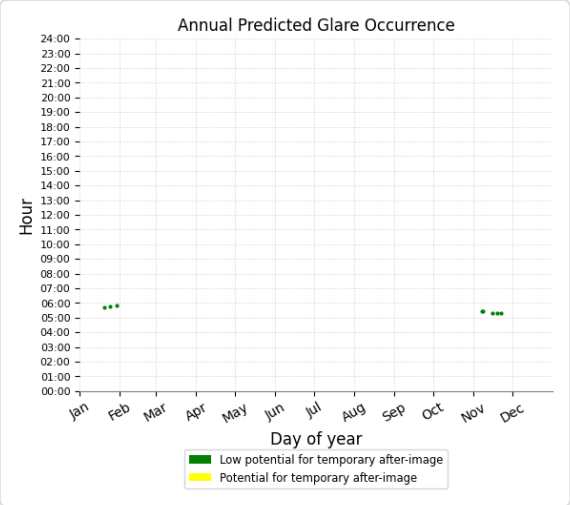
Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	8	0.1	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

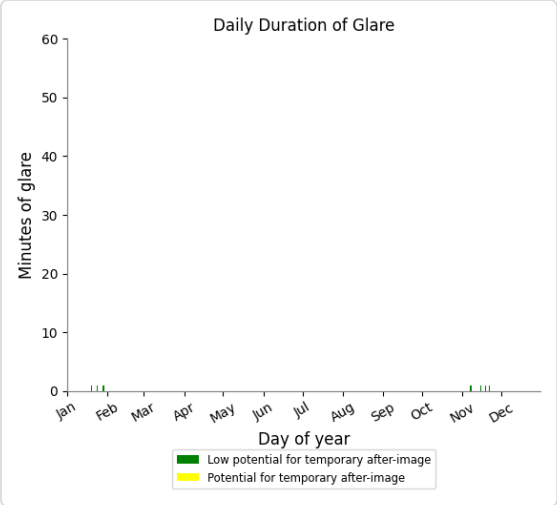
PV Array Area 01 and Clifton Road

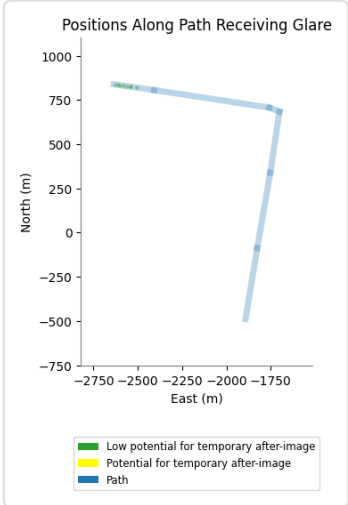
Receptor type: Route

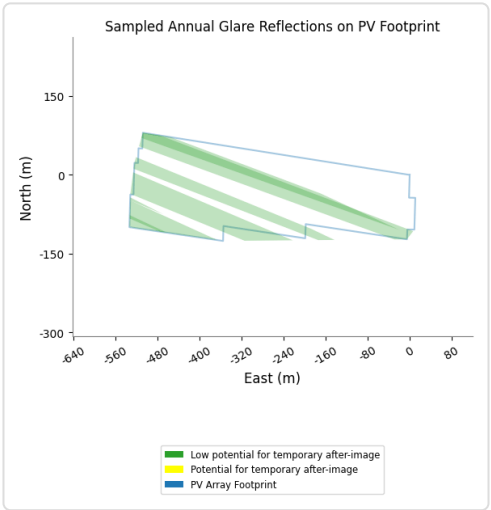
0 minutes of yellow glare

8 minutes of green glare









PV Array Area 01 and Geelong-Ballan Road

Receptor type: Route
No glare found

PV Array Area 01 and Pringles Road

Receptor type: Route
No glare found

PV Array Area 01 and Southerlands Creek Road

Receptor type: Route
No glare found

PV Array Area 01 and OP 1

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 2

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 3

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 4

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 5

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 6

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 7

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 8

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 9

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 10

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 11

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 12

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 13

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 14

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 15

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 16

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 17

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 18

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 19

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 20

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 21

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 22

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 23

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 5 20220801**
Analysis conducted by David Moir (itsupport@moirla.com.au) at 00:39 on 01 Aug, 2022.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 73364.11981
Methodology: V2

PV Array(s)

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.248739	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Route Receptor(s)

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238435	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Array Area 01	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Results for: PV Array Area 01

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Route: Clifton Road

0 minutes of yellow glare
0 minutes of green glare

Route: Geelong-Ballan Road

0 minutes of yellow glare
0 minutes of green glare

Route: Pringles Road

0 minutes of yellow glare
0 minutes of green glare

Route: Southerlands Creek Road

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 5 20220801**

Client: NGH

Created 01 Aug, 2022
Updated 01 Aug, 2022
Time-step 1 minute
Timezone offset UTC10
Site ID 73364.11981
Category 1 MW to 5 MW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 5.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Route Receptors

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238436	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.249730	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV: PV Array Area 01 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV Array Area 01 and Clifton Road

Receptor type: Route

No glare found

PV Array Area 01 and Geelong-Ballan Road

Receptor type: Route

No glare found

PV Array Area 01 and Pringles Road

Receptor type: Route

No glare found

PV Array Area 01 and Southerlands Creek Road

Receptor type: Route

No glare found

PV Array Area 01 and OP 1

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 2

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 3

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 4

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 5

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 6

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 7

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 8

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 9

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 10

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 11

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 12

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 13

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 14

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 15

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 16

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 17

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 18

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 19

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 20

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 21

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 22

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 23

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 22 20220801**
Analysis conducted by David Moir (itsupport@moirla.com.au) at 00:42 on 01 Aug, 2022.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 73365.11981
Methodology: V2

PV Array(s)

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 22.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.248739	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Route Receptor(s)

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238435	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Array Area 01	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Results for: PV Array Area 01

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Route: Clifton Road

0 minutes of yellow glare
0 minutes of green glare

Route: Geelong-Ballan Road

0 minutes of yellow glare
0 minutes of green glare

Route: Pringles Road

0 minutes of yellow glare
0 minutes of green glare

Route: Southerlands Creek Road

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 22 20220801**

Client: NGH

Created 01 Aug, 2022
Updated 01 Aug, 2022
Time-step 1 minute
Timezone offset UTC10
Site ID 73365.11981
Category 1 MW to 5 MW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 22.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Route Receptors

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238436	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.249730	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV: PV Array Area 01 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV Array Area 01 and Clifton Road

Receptor type: Route

No glare found

PV Array Area 01 and Geelong-Ballan Road

Receptor type: Route

No glare found

PV Array Area 01 and Pringles Road

Receptor type: Route

No glare found

PV Array Area 01 and Southerlands Creek Road

Receptor type: Route

No glare found

PV Array Area 01 and OP 1

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 2

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 3

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 4

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 5

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 6

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 7

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 8

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 9

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 10

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 11

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 12

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 13

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 14

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 15

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 16

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 17

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 18

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 19

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 20

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 21

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 22

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 23

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 45 20220801**
Analysis conducted by David Moir (itsupport@moirla.com.au) at 00:46 on 01 Aug, 2022.

U.S. FAA 2013 Policy Adherence

The following table summarizes the policy adherence of the glare analysis based on the 2013 U.S. Federal Aviation Administration Interim Policy 78 FR 63276. This policy requires the following criteria be met for solar energy systems on airport property:

- No "yellow" glare (potential for after-image) for any flight path from threshold to 2 miles
- No glare of any kind for Air Traffic Control Tower(s) ("ATCT") at cab height.
- Default analysis and observer characteristics (see list below)

ForgeSolar does not represent or speak officially for the FAA and cannot approve or deny projects. Results are informational only.

COMPONENT	STATUS	DESCRIPTION
Analysis parameters	PASS	Analysis time interval and eye characteristics used are acceptable
2-mile flight path(s)	N/A	No flight paths analyzed
ATCT(s)	N/A	No ATCT receptors designated

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians

FAA Policy 78 FR 63276 can be read at https://www.federalregister.gov/d/2013-24729

SITE CONFIGURATION

Analysis Parameters

DNI: peaks at 1,000.0 W/m^2
Time interval: 1 min
Ocular transmission coefficient: 0.5
Pupil diameter: 0.002 m
Eye focal length: 0.017 m
Sun subtended angle: 9.3 mrad
Site Config ID: 73367.11981
Methodology: V2

PV Array(s)

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 45.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Discrete Observation Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.248739	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Route Receptor(s)

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238435	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Note: Route receptors are excluded from this FAA policy review. Use the 2-mile flight path receptor to simulate flight paths according to FAA guidelines.

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

GLARE ANALYSIS RESULTS

Summary of Glare

PV Array Name	Tilt (°)	Orient (°)	"Green" Glare min	"Yellow" Glare min	Energy kWh
PV Array Area 01	SA tracking	SA tracking	0	0	-

Total annual glare received by each receptor

Receptor	Annual Green Glare (min)	Annual Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Results for: PV Array Area 01

Receptor	Green Glare (min)	Yellow Glare (min)
OP 1	0	0
OP 2	0	0
OP 3	0	0
OP 4	0	0
OP 5	0	0
OP 6	0	0
OP 7	0	0
OP 8	0	0
OP 9	0	0
OP 10	0	0
OP 11	0	0
OP 12	0	0
OP 13	0	0
OP 14	0	0
OP 15	0	0
OP 16	0	0
OP 17	0	0
OP 18	0	0
OP 19	0	0
OP 20	0	0
OP 21	0	0
OP 22	0	0
OP 23	0	0
Clifton Road	0	0
Geelong-Ballan Road	0	0
Pringles Road	0	0
Southerlands Creek Road	0	0

Point Receptor: OP 1

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 2

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 3

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 4

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 5

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 6

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 7

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 8

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 9

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 10

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 11

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 12

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 13

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 14

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 15

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 16

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 17

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 18

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 19

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 20

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 21

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 22

0 minutes of yellow glare
0 minutes of green glare

Point Receptor: OP 23

0 minutes of yellow glare
0 minutes of green glare

Route: Clifton Road

0 minutes of yellow glare
0 minutes of green glare

Route: Geelong-Ballan Road

0 minutes of yellow glare
0 minutes of green glare

Route: Pringles Road

0 minutes of yellow glare
0 minutes of green glare

Route: Southerlands Creek Road

0 minutes of yellow glare
0 minutes of green glare

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
Glare analyses do not account for physical obstructions between reflectors and receptors. This includes buildings, tree cover and geographic obstructions.
Several calculations utilize the PV array centroid, rather than the actual glare spot location, due to V1 algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Glare vector plots are simplified representations of analysis data. Actual glare emanations and results may differ.
The glare hazard determination relies on several approximations including observer eye characteristics, angle of view, and typical blink response time. Actual results and glare occurrence may differ.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

FORGESOLAR GLARE ANALYSIS

Project: **2152 ANAKIE SOLAR FARM**
2152 ANAKIE SOLAR FARM

Site configuration: **2152 ANAKIE SOLAR FARM BCTR ANGLE 45 20220801**

Client: NGH

Created 01 Aug, 2022
Updated 01 Aug, 2022
Time-step 1 minute
Timezone offset UTC10
Site ID 73367.11981
Category 1 MW to 5 MW
DNI peaks at 1,000.0 W/m^2
Ocular transmission coefficient 0.5
Pupil diameter 0.002 m
Eye focal length 0.017 m
Sun subtended angle 9.3 mrad
Methodology V2

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

Component Data

PV Arrays

Name: PV Array Area 01
Axis tracking: Single-axis rotation
Backtracking: Instant
Tracking axis orientation: 0.0°
Tracking axis tilt: 0.74°
Tracking axis panel offset: 0.0°
Max tracking angle: 60.0°
Resting angle: 45.0°
Rated power: -
Panel material: Smooth glass without AR coating
Reflectivity: Vary with sun
Slope error: correlate with material

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.968306	144.269431	109.64	5.10	114.74
2	-37.968697	144.269417	109.78	5.10	114.88
3	-37.968700	144.269553	110.22	5.10	115.32
4	-37.969244	144.269533	109.89	5.10	114.99
5	-37.969242	144.269381	110.04	5.10	115.14
6	-37.969411	144.269372	110.00	5.10	115.10
7	-37.969150	144.267178	114.68	5.10	119.78
8	-37.969394	144.267167	114.95	5.10	120.05
9	-37.969183	144.265394	111.05	5.10	116.15
10	-37.969439	144.265386	112.10	5.10	117.20
11	-37.969203	144.263356	110.27	5.10	115.37
12	-37.968644	144.263375	109.56	5.10	114.66
13	-37.968644	144.263444	109.89	5.10	114.99
14	-37.968100	144.263464	109.02	5.10	114.12
15	-37.968100	144.263544	109.23	5.10	114.33
16	-37.967850	144.263553	109.00	5.10	114.10
17	-37.967853	144.263636	109.00	5.10	114.10
18	-37.967583	144.263647	109.00	5.10	114.10

Route Receptors

Name: Clifton Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.972714	144.247898	87.51	2.40	89.91
2	-37.969094	144.248649	92.65	2.40	95.05
3	-37.965254	144.249486	91.60	2.40	94.00
4	-37.962141	144.250076	95.25	2.40	97.65
5	-37.961938	144.249422	95.28	2.40	97.68
6	-37.961050	144.242030	95.39	2.40	97.79
7	-37.960754	144.239444	97.59	2.40	99.99

Name: Geelong-Ballan Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.946315	144.265812	137.99	2.40	140.39
2	-37.948531	144.266027	132.08	2.40	134.48
3	-37.951543	144.266349	128.06	2.40	130.46
4	-37.954521	144.266627	123.45	2.40	125.85
5	-37.958159	144.267035	113.28	2.40	115.68
6	-37.960498	144.267226	111.24	2.40	113.64
7	-37.963940	144.268385	110.00	2.40	112.40
8	-37.966847	144.269378	110.28	2.40	112.68
9	-37.970180	144.270558	109.98	2.40	112.38
10	-37.973825	144.271749	107.98	2.40	110.38
11	-37.978377	144.273371	108.27	2.40	110.67
12	-37.982048	144.274626	99.63	2.40	102.03
13	-37.986484	144.276159	93.64	2.40	96.04
14	-37.991270	144.277940	87.40	2.40	89.80

Name: Pringles Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.975739	144.272345	108.97	2.40	111.37
2	-37.975396	144.269255	105.37	2.40	107.77
3	-37.974935	144.265366	107.97	2.40	110.37
4	-37.974297	144.259921	106.06	2.40	108.46
5	-37.973768	144.255710	100.29	2.40	102.69
6	-37.973132	144.250505	92.41	2.40	94.81
7	-37.972671	144.246536	86.29	2.40	88.69
8	-37.972122	144.242083	85.75	2.40	88.15
9	-37.971885	144.239895	85.63	2.40	88.03
10	-37.972223	144.238436	87.04	2.40	89.44

Name: Southerlands Creek Road
Path type: Two-way
Observer view angle: 50.0°

Vertex	Latitude (°)	Longitude (°)	Ground elevation (m)	Height above ground (m)	Total elevation (m)
1	-37.987490	144.250935	81.12	2.40	83.52
2	-37.984792	144.251525	87.73	2.40	90.13
3	-37.982069	144.252019	101.33	2.40	103.73
4	-37.979397	144.252555	114.45	2.40	116.85
5	-37.976708	144.253038	103.63	2.40	106.03
6	-37.975270	144.253324	101.50	2.40	103.90
7	-37.973565	144.253635	98.57	2.40	100.97

Discrete Observation Point Receptors

Name	ID	Latitude (°)	Longitude (°)	Elevation (m)	Height (m)
OP 1	1	-37.967643	144.267038	109.77	1.50
OP 2	2	-37.962399	144.253757	99.24	1.50
OP 3	3	-37.964461	144.251943	94.34	1.50
OP 4	4	-37.968523	144.251101	92.33	1.50
OP 5	5	-37.971616	144.253401	98.17	1.50
OP 6	6	-37.971350	144.266242	116.09	1.50
OP 7	7	-37.971269	144.267181	117.79	1.50
OP 8	8	-37.972208	144.267058	116.71	1.50
OP 9	9	-37.977064	144.265575	102.00	1.50
OP 10	10	-37.976899	144.271412	107.88	1.50
OP 11	11	-37.977861	144.274978	109.00	1.50
OP 12	12	-37.984062	144.251315	91.11	1.50
OP 13	13	-37.978203	144.246536	95.53	1.50
OP 14	14	-37.973644	144.242626	84.81	1.50
OP 15	15	-37.984449	144.277955	100.00	1.50
OP 16	16	-37.972560	144.285913	99.05	1.50
OP 17	17	-37.964759	144.272337	106.35	1.50
OP 18	18	-37.952480	144.264137	125.66	1.50
OP 19	19	-37.970478	144.261092	106.59	1.50
OP 20	20	-37.970811	144.265609	115.05	1.50
OP 21	21	-37.968214	144.251715	94.34	1.50
OP 22	22	-37.967942	144.249730	94.09	1.50
OP 23	23	-37.974195	144.285156	100.00	1.50

Glare Analysis Results

Summary of Results No glare predicted

PV Array	Tilt	Orient	Annual Green Glare		Annual Yellow Glare		Energy
	°	°	min	hr	min	hr	kWh
PV Array Area 01	SA tracking	SA tracking	0	0.0	0	0.0	-

Total annual glare received by each receptor; may include duplicate times of glare from multiple reflective surfaces.

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV: PV Array Area 01 no glare found

Receptor results ordered by category of glare

Receptor	Annual Green Glare		Annual Yellow Glare	
	min	hr	min	hr
Clifton Road	0	0.0	0	0.0
Geelong-Ballan Road	0	0.0	0	0.0
Pringles Road	0	0.0	0	0.0
Southerlands Creek Road	0	0.0	0	0.0
OP 1	0	0.0	0	0.0
OP 2	0	0.0	0	0.0
OP 3	0	0.0	0	0.0
OP 4	0	0.0	0	0.0
OP 5	0	0.0	0	0.0
OP 6	0	0.0	0	0.0
OP 7	0	0.0	0	0.0
OP 8	0	0.0	0	0.0
OP 9	0	0.0	0	0.0
OP 10	0	0.0	0	0.0
OP 11	0	0.0	0	0.0
OP 12	0	0.0	0	0.0
OP 13	0	0.0	0	0.0
OP 14	0	0.0	0	0.0
OP 15	0	0.0	0	0.0
OP 16	0	0.0	0	0.0
OP 17	0	0.0	0	0.0
OP 18	0	0.0	0	0.0
OP 19	0	0.0	0	0.0
OP 20	0	0.0	0	0.0
OP 21	0	0.0	0	0.0
OP 22	0	0.0	0	0.0
OP 23	0	0.0	0	0.0

PV Array Area 01 and Clifton Road

Receptor type: Route

No glare found

PV Array Area 01 and Geelong-Ballan Road

Receptor type: Route

No glare found

PV Array Area 01 and Pringles Road

Receptor type: Route

No glare found

PV Array Area 01 and Southerlands Creek Road

Receptor type: Route

No glare found

PV Array Area 01 and OP 1

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 2

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 3

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 4

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 5

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 6

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 7

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 8

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 9

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 10

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 11

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 12

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 13

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 14

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 15

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 16

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 17

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 18

Receptor type: Observation Point

No glare found

PV Array Area 01 and OP 19

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 20

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 21

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 22

Receptor type: Observation Point
No glare found

PV Array Area 01 and OP 23

Receptor type: Observation Point
No glare found

Assumptions

"Green" glare is glare with low potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
"Yellow" glare is glare with potential to cause an after-image (flash blindness) when observed prior to a typical blink response time.
Times associated with glare are denoted in Standard time. For Daylight Savings, add one hour.
The algorithm does not rigorously represent the detailed geometry of a system; detailed features such as gaps between modules, variable height of the PV array, and support structures may impact actual glare results. However, we have validated our models against several systems, including a PV array causing glare to the air-traffic control tower at Manchester-Boston Regional Airport and several sites in Albuquerque, and the tool accurately predicted the occurrence and intensity of glare at different times and days of the year.
Several V1 calculations utilize the PV array centroid, rather than the actual glare spot location, due to algorithm limitations. This may affect results for large PV footprints. Additional analyses of array sub-sections can provide additional information on expected glare. This primarily affects V1 analyses of path receptors.
Random number computations are utilized by various steps of the annual hazard analysis algorithm. Predicted minutes of glare can vary between runs as a result. This limitation primarily affects analyses of Observation Point receptors, including ATCTs. Note that the SGHAT/ ForgeSolar methodology has always relied on an analytical, qualitative approach to accurately determine the overall hazard (i.e. green vs. yellow) of expected glare on an annual basis.
The analysis does not consider obstacles (either man-made or natural) between the observation points and the prescribed solar installation that may obstruct observed glare, such as trees, hills, buildings, etc.
The subtended source angle (glare spot size) is constrained by the PV array footprint size. Partitioning large arrays into smaller sections will reduce the maximum potential subtended angle, potentially impacting results if actual glare spots are larger than the sub-array size. Additional analyses of the combined area of adjacent sub-arrays can provide more information on potential glare hazards. (See previous point on related limitations.)
The variable direct normal irradiance (DNI) feature (if selected) scales the user-prescribed peak DNI using a typical clear-day irradiance profile. This profile has a lower DNI in the mornings and evenings and a maximum at solar noon. The scaling uses a clear-day irradiance profile based on a normalized time relative to sunrise, solar noon, and sunset, which are prescribed by a sun-position algorithm and the latitude and longitude obtained from Google maps. The actual DNI on any given day can be affected by cloud cover, atmospheric attenuation, and other environmental factors.
The ocular hazard predicted by the tool depends on a number of environmental, optical, and human factors, which can be uncertain. We provide input fields and typical ranges of values for these factors so that the user can vary these parameters to see if they have an impact on the results. The speed of SGHAT allows expedited sensitivity and parametric analyses.
The system output calculation is a DNI-based approximation that assumes clear, sunny skies year-round. It should not be used in place of more rigorous modeling methods.
Hazard zone boundaries shown in the Glare Hazard plot are an approximation and visual aid based on aggregated research data. Actual ocular impact outcomes encompass a continuous, not discrete, spectrum.
Glare locations displayed on receptor plots are approximate. Actual glare-spot locations may differ.
Refer to the Help page at **www.forgesolar.com/help/** for assumptions and limitations not listed here.

Default glare analysis parameters and observer eye characteristics (for reference only):

- Analysis time interval: 1 minute
- Ocular transmission coefficient: 0.5
- Pupil diameter: 0.002 meters
- Eye focal length: 0.017 meters
- Sun subtended angle: 9.3 milliradians